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Some rare Myxomycetes of central New York, with notes on the germination of Enteridium Rozeanum.

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WITH PLATES IX AND X.

The lake region of New York state is famous as a botanical collecting ground. In the Cayuga region alone 1,278 species of phanerogams have been catalogued. Although flowering plants are so abundant, ferns, mosses, algæ and fungi occur in great profusion. The Myxomycetes form no exception to this rule. The multitude of gorges and ravines, which render the region of Ithaca picturesque and unique among our lake valleys, presents an environment very favorable to the development of these singular organisms.

A large number of Myxomycetes have been collected near Ithaca at various times, but especially during the last two years. Many interesting species have been found, several of which will be noted in this paper.

I. Rare Myxomycetes.

ARCYRIA MACROSPORA Peck, 34th Rep. of the N. Y. State Mus. Nat. Hist., 1881, p. 43. — This species illustrates the fact, that the characters of species of Myxomycetes depend largely upon the power of the objective used in their study. Markings which appear to be of a certain character, when viewed with a one-fifth inch objective, are found to be entirely different when examined with a one-twelfth inch oil immersion objective. For example, the spores of *Trichia fallax* have long been described as warted, but under the one-twelfth inch objective, the epispore is found to be delicately reticulated. Dr. Peck evidently based his description of *Arcyria macrospora* upon observations made with the lower

powers of the microscope. Under the highest powers, the characters appear to be so different as to be scarcely recognizable. I, therefore, redescribe the species on this basis.

The description is drawn from material in the Cornell University Herbarium, collected at Ithaca in 1879, and sent to Dr. Peck, in 1880, for determination. It is labeled "*Arcyria macrospora* Peck, n. sp.," and is referred to by him in his description (l. c.).

Plants crowded or gregarious, stipitate, collected on a common hypothallus. Sporangia globose, or shortly elliptical, deep brick-red in color, with a shade of brown. Dehiscence circumscissile. Hypothallus yellowish-brown, shining, forming a broad thin sheet, on which the sporangia stand. The stipe equals the sporangium in length, and is dark brown, almost black in color. The base of the sporangium after dehiscence forms a shallow cup, in the center of which the capillitium is loosely attached, much as in *A. adnata.* The capillitium is dense, with the spore-mass deep brick-red in color when fresh, fading to cinnamon brown with age. The capillitial threads are about 6μ in diameter, and are quite closely combined into a net. The markings consist of broad raised bands, closely combined in a reticulate manner. The bands are so thick, that they appear as coarse warts when seen in cross section along the edge of the thread. The spores are minutely verrucose, and very large, being 10–13μ in diameter. Plate IX, figs. 1, 3; plate X, fig. 9.

This is a very distinct species, being strikingly different from all of our other species of *Arcyria.* Externally the appearance is much like that presented by specimens of *A. adnata*, but the internal characters of the species are recognizable at a glance. The large size and peculiar markings of the capillitial threads, together with the large warted spores, are peculiarities which cannot be overlooked.

The description is much the same as that of *A. inermis* Racib. Myx. Cracov., 1885, as given in Massee's Monograph. If the species be identical, Peck's name has the priority by four years.

This species seems as yet to be quite rare. The only localities known at present are: Copake, Columbia Co.; Grafton, Rensselaer Co., and Ithaca, Tompkins Co.; all in New York. The Copake and Grafton localities are given on the authority of Dr. C. H. Peck.

The plant was noticed at Ithaca first in 1879, when it was collected from a hemlock log, in Fall creek ravine. On April 13, 1893, I collected specimens from the same station. In June, 1893, a few specimens were found in Cascadilla ravine also, on a hemlock stump. I suspect that the species has been overlooked on account of its external resemblance to *A. punicea* and *A. adnata*.

CRIBRARIA PURPUREA Schrader, Nov. Pl. Gen., p. 8, 1797.—Plants usually scattered. The hypothallus is small but distinct, formed only of the thick, expanded foot of the stipe. Stem rather elongated, usually two or three times as long as the diameter of the sporangium, dark purple. Sporangium large, globose, reddish purple. The calyculus occupies rather less than one-half of the sporangium, and is usually ribbed. The thickened portions of the sporangium form an irregular net-work. The nodes are irregular in form, but are somewhat elongated, and filled with purple granules. The connecting threads are nearly colorless, with numerous free branches, in the form of short projections, or of threads which are not connected with any node. The spores are purple in mass, but colorless by transmitted light. They are 5–6.5μ in diameter, smooth.

This is a fine species, very distinct from *C. elegans* B. & C., with which it is perhaps confused. It is the largest and by far the most beautiful species of the whole genus. It usually covers considerable areas on the log where it occurs. When the spores are dispersed they lodge on the mosses and rotten wood, when the deep purple color is very conspicuous, so that it may be seen from a considerable distance.

The species is by no means common, and is usually found in cool or mountainous regions. Dr. Peck writes me that he has found it in the Adirondack and Catskill mountains, and at Sand Lake, New York. He has received it from Canada, (*Macoun*) and from Maine (*Harvey*). At Ithaca three stations are known: Six-mile creek, Fall creek, and Coy glen. At these places the plants grow on logs, the individuals standing indifferently on mosses or the rotten wood. Plate IX, figs. 2, 4, 5.

TRICHIA ERECTA Rex, Proc. Phil. Acad. Sci., 1890, p. 193.—A small quantity of this rare myxomycete was collected from a rotten log, in Coy glen, near Ithaca, April 15, 1893. The specimens correspond very well to the descrip-

tion by Dr. Rex, and are almost exactly similar to the material distributed as no. 2,496 of the North American Fungi.

Dr. Rex has given an excellent account of the species in the proceedings cited above. The only station known at that time was in the Adirondack mountains. Whether additional ones have been discovered since, I am not able to state. This is a fine species, distinguished among the Trichias by the stipitate checkered sporangia, the spinulose cylindrical elaters, and the warted spores.

II. Germination of Enteridium Rozeanum.

ENTERIDIUM ROZEANUM (Rost.) Wing.—It is my purpose in this part to present some of the results of studies upon the swarm-cells of Enteridium Rozeanum. These investigations were undertaken during the winter of 1893, as a part of some special work upon the group of organisms to which this plant belongs. The material from which the cultures were made was collected from an old log on Fall creek flats, an extensive swamp at the head of Cayuga Lake. The plants were found about the middle of October, 1892, and put away in a dry place. In December, the germination of the spores of a large number of species collected during the fall was tried, but those of Enteridium were the only ones which showed any signs of germination. I considered myself fortunate to have succeeded even so much, for the difficulties in the way of germinating the spores of Myxomycetes are well known.

As is the case with many fungi, myxomycete spores require a period of rest before germination will take place. The length of this period seems to vary, not only according to the species, but also according to the conditions under which the spores are kept. Fully as important a consideration is the medium in which the germination is attempted.

The method of culture which I employed was the well-known moist chamber formed from several thicknesses of filter paper, wet with distilled water, sustaining a cover-glass, upon which, in a hanging drop of water, the spores were sown. The best temperature for germination seems to be about 70° F.

When about to germinate, the spore absorbs water, the protoplasm swells, rupturing the wall of the spore along one side. Through the **V**-shaped opening thus made the nucleated protoplasm flows or streams out in a mass (plate IX, figs. 6, 7, 8). After leaving the spore the protoplasm, or, as

it is now called, the swarm-cell, becomes spherical, and undergoes a short period of rest (plate X, fig. 10). The swarm-cells at this time measure about 9μ in diameter. This diameter is found to be, on an average, about one and one-half times that of the original spore.

After remaining in the spherical resting state for a short but variable time, the swarm-cell assumes a new form. The body elongates, becoming cylindrical or fusiform, measuring about 12$\mu \times$ 2–3μ. At one end a cilium is produced which is long and lash-like, three to five times as long as the long diameter of the cell body. Often two cilia are produced,—*one at each end* (plate X, fig. 12). This biciliate condition seems to be peculiar to Enteridium Rozeanum, so far as I have been able to ascertain. De Bary mentions the fact that two cilia are occasionally produced, but his figures represent both cilia at the same end.

By the lashing of the cilium the swarm-cell is made to move rapidly through the water, executing what De Bary calls the "hopping movement." I cannot see the appropriateness of this term. It appeals to me more as an oscillatory or undulatory motion. Through the rapid lashing of the cilium, the body oscillates as if hung on a pivot at the center. The cell meanwhile is in constant amoeboid movement, so that its form is constantly changing, to a limited extent. The form of the body does not change as a result of the motion of the cilium, but by virtue of some force within the body of the cell itself. The vibration seems to be in a horizontal plane, and not the double conical or figure-of-eight movement possessed by many bacteria. In the case of the biciliate swarm-cells, the kind of movement does not differ materially from that of those with one cilium. The oscillatory movement is the same, but its rapidity is much increased. In many cases it is almost impossible to follow a vigorous cell in its vibrations, so rapidly does it move.

The general shape of the uniciliate swarm-cell is fusiform, the cilium being at the smaller, pointed end. In almost every instance, the uniciliate swarm-cells of Enteridium Rozeanum possess a curious appendage at the larger, posterior end (plate X, fig. 11). This consists of a spherical mass of protoplasm, with a diameter slightly less than the short diameter of the cell body. This appendage contains a vacuole, and is joined to the cell body by a short thread of protoplasm. In

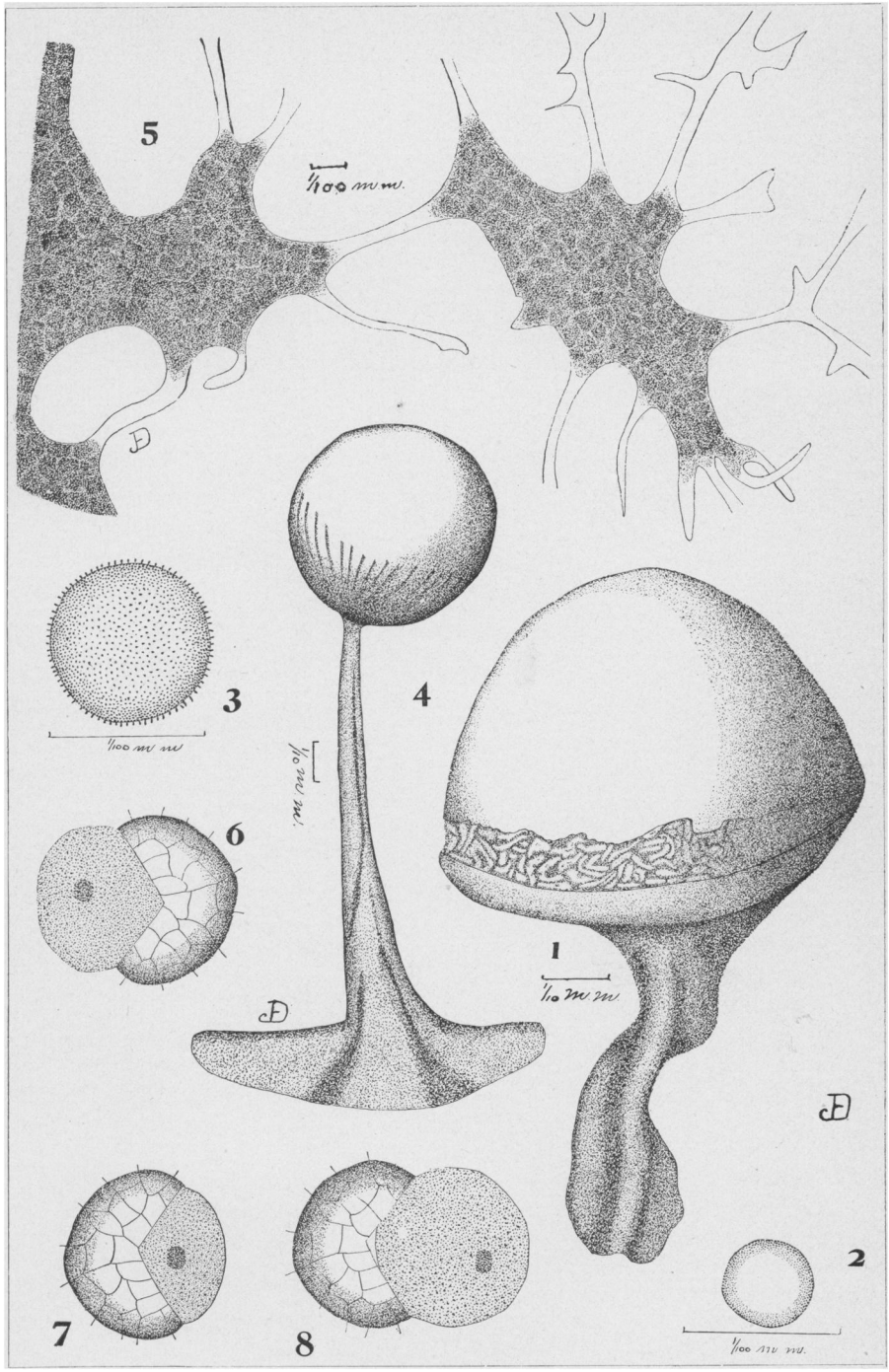
no instance have I observed this separating from the cell body. I did not once observe the creeping movement of the swarm-cell described by De Bary and Lister. When this movement is begun, the oscillatory movement is said to cease, while the cell moves slowly along the glass, with the cilium directed forward.

In the course of its amoeboid movement the cell assumes many forms. Sometimes it is nearly straight. Again it will be bent double, so that the anterior and posterior ends are nearly in contact. At other times protrusions or pseudopodia appear in parts of the cell, so that the body assumes almost numberless outlines.

The swarm-cells, after remaining two or three days in the ciliated state, absorb their cilia and pass into an amoeboid stage, when they are nearly spherical in form. Amoeboid movement takes place constantly, although but slowly and to a slight degree (plate X, figs. 13, 14, 15). It is at this time that division takes place. This process I now outline as observed in the case of a single swarm-cell. When first noticed the cell appeared a little longer than broad. While under observation, it lengthened slightly, and a constriction appeared on each side in the middle of its length. This constriction gradually deepened, as if a cord, tied around the cell, were being drawn so as to cut it in two. As the process continued the constriction became deeper and deeper on each side, until finally the two parts were held together by only a narrow thread of protoplasm. In time, this also disappeared, and the two parts became distinct and separated from each other. Each was then spherical in form. The time occupied in this division was about thirty seconds.

After undergoing division for a time, the spherical swarm-cells collected into small groups or colonies. In these cells, which are closely packed together, the thin layer of ectoplasm occupying a little less than one-fourth of the radius, appears clear and transparent. Within, the granular endoplasm contains the nucleus and vacuoles (plate X, fig. 16). This differentiation of the protoplasm is not apparent in the swarm-cells under other conditions. The cells retain their individuality for a time, but are soon seen to be blending together into a common mass, the young plasmodium (plate X, fig. 17).

The plasmodia are about 24μ in diameter, whereas the spherical swarm-cells are only about 9μ. Whether the nuclei



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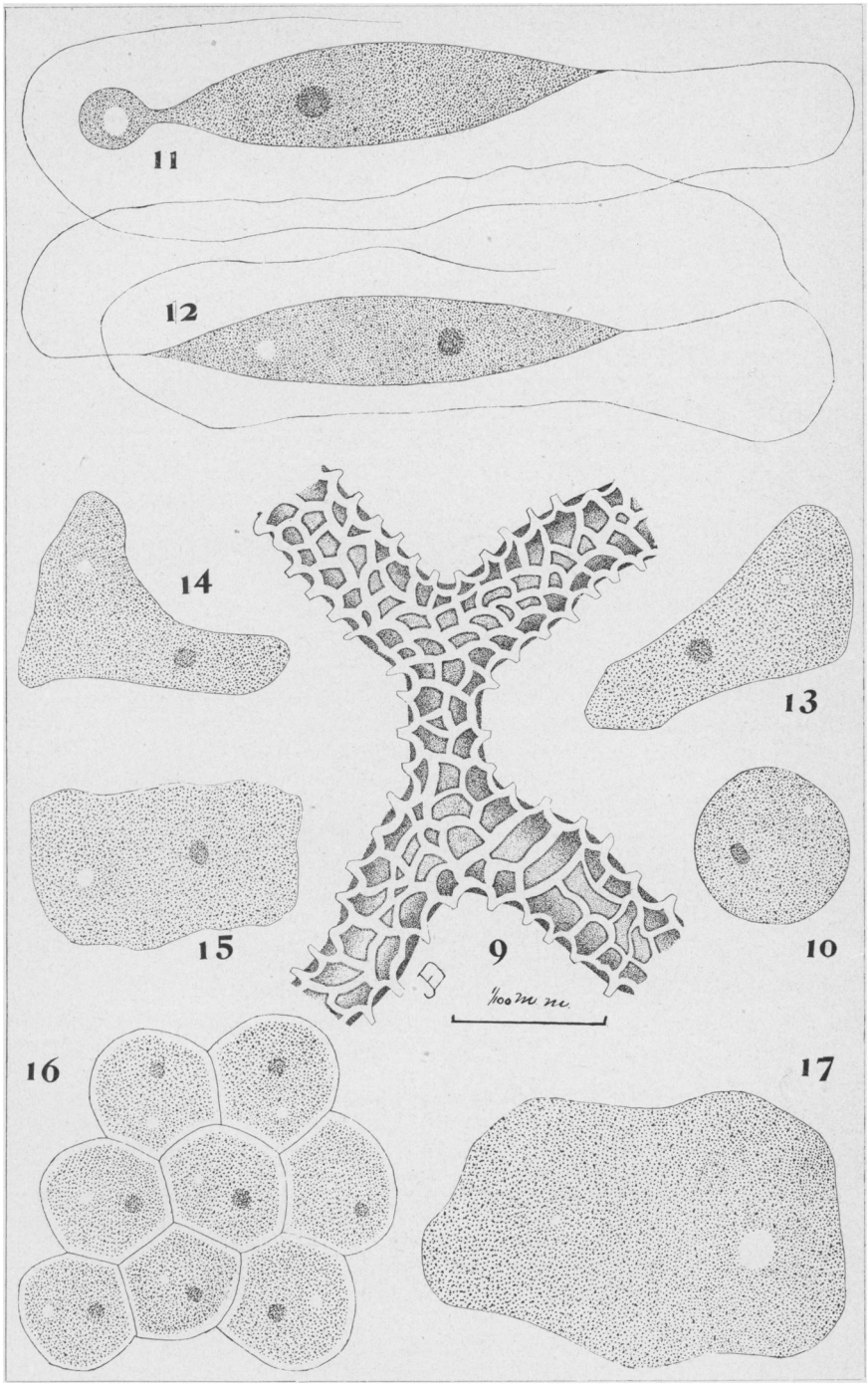

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of the cells remain distinct in the young plasmodium, I was not able to determine. But in the plasmodium there is only one contractile vacuole, while each of the component cells contained one. The movements of the mass are distinctly amoeboid, and the protoplasmic currents can be clearly seen in the plasmodium as it moves slowly from place to place. The expansion of the contractile vacuole is very gradual until it attains its full size. After remaining expanded for a moment it suddenly disappears entirely. The time occupied from one disappearance to another is from forty to sixty seconds.

In the movement of the young plasmodium the protoplasm flows in a definite direction for a time, until a large pseudopod is formed. The rest of the plasmodium then flows into the pseudo pod. The movement is that of the whole mass in a definite direction. The young plasmodium meanwhile is irregular in outline, owing to the putting out of small pseudopods from all sides of the mass.

I was unable to induce the development of this species beyond the young plasmodial stage. Many different methods of culture were tried, with many different media, but all without success. I was particularly desirous of obtaining a mature plasmodium of this species, in order to study the formation of the æthalium. As is well known, the arrangement of sporangia in the æthalium is very complicated, and the mode of their formation and union is at present unknown. Perhaps some one, more fortunate than myself, may be able to complete these observations, and work out this interesting structure.

My acknowledgments are due to Prof. G. F. Atkinson for suggestions and kindly advice in carrying out this study.

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EXPLANATION OF PLATES IX AND X.—The scale where known is indicated with each figure. Figures 6–8, and 10–17 are drawn without reference to a scale; in these figures the unbroken lines surrounding the protoplasm are to be understood as indicating boundaries only, and in no case cell walls.

Fig. 1. sporangium of *Arcyria macrospora*.—Fig. 2, spore of *Cribraria purpurea*.—Fig. 3, spore of *Arcyria macrospora*.—Fig. 4, sporangium of *Cribraria purpurea*.—Fig. 5, portion of sporangial wall of same.—Figs. 6–8, germinating spores of *Enteridium Rozeanum*.—Fig. 9, portion of capillitium of *Arcyria macrospora*.—Fig. 10, spherical swarm-cell of *Enteridium*.—Fig. 11, ciliated swarm-cell with appendage.—Fig. 12, biciliated swarm-cell.—Figs. 13–15, amœboid swarm-cells.—Fig. 16, coalescing swarm-cells.—Fig. 17, young plasmodium.